AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior listing of claims in this application.

1. (Previously presented) A method of forming a copper damascene structure, said method comprising the steps of:

providing a metal layer within a semiconductor substrate;

forming a low-dielectric constant layer over and in contact with said metal layer;

directly patterning said low-dielectric constant layer to form at least one opening through said low-dielectric constant layer, said opening extending to at least a portion of said metal layer;

forming a tungsten nitride layer by atomic-layer deposition using sequential surface reactions, said tungsten nitride layer being in contact with said at least one opening;

removing horizontal portions of said tungsten nitride layer formed above a surface of said low-dielectric constant layer by chemical mechanical polishing; and

subsequently providing a copper layer in said at least one opening and in contact with said tungsten nitride layer, wherein said copper layer is selectively deposited by low-temperature metal-organic chemical vapor deposition.

2. (Previously presented) The method of claim 1, wherein said low-dielectric constant layer includes a material selected from the group consisting of methylsilsequiazane, polyimide, spin-on-polymers, flare, polyarylethers, parylene,

polytetrafluoroethylene, benzocyclobutene, fluorinated silicon oxide, and hydrogen silsesquioxane.

3. (Original) The method of claim 1, wherein said low-dielectric constant layer comprises methylsilsequiazane.

4. (Previously presented) The method of claim 3, wherein said step of forming said at least one opening further comprises patterning said methylsilsequiazane layer with a mask.

5. (Original) The method of claim 4, wherein said step of patterning said low-dielectric constant layer further comprises exposing said low-dielectric constant layer to an electron beam or ultra violet light.

6. (Original) The method of claim 5, wherein said step of forming said at least one opening further comprises etching said low-dielectric constant layer with a tetra-methyl-ammonium hydroxide solution.

7. (Original) The method of claim 3, wherein said low-dielectric constant layer is formed by spin coating to a thickness of about 2,000 to 50,000 Angstroms.

8. (Original) The method of claim 7, wherein said low-dielectric constant layer is formed by spin coating to a thickness of about 5,000 to 20,000 Angstroms.

9. (Original) The method of claim 1, wherein said tungsten nitride layer is formed at a temperature of about 550-800K.

Claim 10. (Canceled)

11. (Previously presented) The method of claim 1, wherein said copper layer is selectively deposited at a temperature of about 300°C to about 400°C.

12. (Original) The method of claim 11, wherein said copper layer is selectively deposited in an atmosphere of pure hydrogen from the β-diketonate precursor bis(6,6,7,8,8,8-heptafluoro-2,2-dimetyl 1-3,5-octanedino) copper (II).

13. (Original) The method of claim 11, wherein said copper layer is selectively deposited in an atmosphere of pure argon from the β-diketonate precursor bis(6,6,7,8,8,8-heptafluoro-2,2-dimetyl 1-3,5-octanedino) copper (II).

14. (Previously presented) A method of forming a copper damascene structure, said method comprising the steps of:

directly patterning a low-dielectric constant layer with a mask to form at least one opening through said low-dielectric constant layer;

forming a tungsten nitride layer by atomic-layer deposition using sequential surface reactions, said tungsten nitride layer being in contact with said at least one opening, said tungsten nitride layer being formed above and in contact with a top surface of said low-dielectric constant layer;

removing horizontal portions of said tungsten nitride layer formed above and in contact with said top surface of said low-dielectric constant layer by chemical mechanical polishing; and

subsequently providing a copper layer in said at least one opening, wherein said copper layer is formed by contact displacement copper deposition at room temperature.

Claim 15. (Canceled)

16. (Original) The method of claim 1 further comprising the act of chemical mechanical polishing said copper layer.

17. (Previously presented) A method of forming a copper damascene structure, said method comprising the steps of:

forming a material layer of methylsilsequiazane over a substrate;

forming at least one opening through said methylsilsequiazane layer by etching said methylsilsequiazane layer with a tetra-methyl-ammonium hydroxide solution;

forming a tungsten nitride layer by atomic-layer deposition using sequential surface reactions, said tungsten nitride layer being in contact with said at least one opening;

removing horizontal portions of said tungsten nitride layer formed above and in contact with a top surface of said methylsilsequiazane layer; and

subsequently providing a copper layer in said at least one opening.

18. (Original) The method of claim 17, wherein said step of forming said at least one opening further comprises directly patterning said methylsilsequiazane layer with a mask to form said at least one opening.

19. (Original) The method of claim 18, wherein said step of directly patterning said methylsilsequiazane layer further comprises exposing said methylsilsequiazane layer to an electron beam or ultra violet light.

Claim 20. (Canceled)

21. (Original) The method of claim 17, wherein said methylsilsequiazane layer is formed by spin coating to a thickness of about 2,000 to 50,000 Angstroms.

22. (Original) The method of claim 21, wherein said methylsilsequiazane layer is formed by spin coating to a thickness of about 5,000 to 20,000 Angstroms.

23. (Original) The method of claim 17, wherein said tungsten nitride layer is formed at a temperature of about 550-800K.

24. (Original) The method of claim 17, wherein said copper layer is selectively deposited by chemical vapor deposition.

25. (Original) The method of claim 24, wherein said copper layer is selectively deposited at a temperature of about 300°C to about 400°C.

26. (Original) The method of claim 25, wherein said copper layer is selectively deposited in an atmosphere of pure hydrogen from the β-diketonate precursor bis(6,6,7,8,8,8-heptafluoro-2,2-dimetyl 1-3,5-octanedino) copper (II).

27. (Original) The method of claim 25, wherein said copper layer is selectively deposited in an atmosphere of pure argon from the β-diketonate precursor bis(6,6,7,8,8,8-heptafluoro-2,2-dimetyl 1-3,5-octanedino) copper (II).

28. (Original) The method of claim 17, wherein said copper layer is formed by electroless deposition.

29. (Original) The method of claim 17 further comprising the act of chemical mechanical polishing said tungsten nitride layer.

30. (Original) The method of claim 17 further comprising the act of chemical mechanical polishing said copper layer.

Claims 31-45. (Canceled)

46. (New) A method of forming a copper damascene structure, said method comprising the steps of:

providing a metal layer within a semiconductor substrate;

forming a low-dielectric constant layer over and in contact with said metal layer;

directly patterning said low-dielectric constant layer to form at least one opening through said low-dielectric constant layer, said opening extending to at least a portion of said metal layer;

forming a tungsten nitride layer by atomic-layer deposition using sequential surface reactions, said tungsten nitride layer being in contact with said at least one opening;

removing horizontal portions of said tungsten nitride layer formed above a surface of said low-dielectric constant layer by chemical mechanical polishing; and

subsequently providing a copper layer in said at least one opening and in contact with said tungsten nitride layer, wherein said copper layer is selectively deposited by low-temperature metal-organic chemical vapor deposition;

wherein said low-dielectric constant layer includes a material selected from the group consisting of methylsilsequiazane, polyimide, spin-on-polymers, flare,

polyarylethers, parylene, polytetrafluoroethylene, benzocyclobutene, fluorinated silicon oxide, and hydrogen silsesquioxane;

wherein said copper layer is selectively deposited at a temperature of about 300°C to about 400°C in an atmosphere from the β-diketonate precursor bis(6,6,7,8,8,8-heptafluoro-2,2-dimetyl 1-3,5-octanedino) copper (II); and

wherein the atmosphere is a pure gas selected from the group consisting of hydrogen and argon.